PROJECT DRIBBLE

U.S. DEPARTMENT OF DEFENSE

U.S. ATOMIC ENERGY COMMISSION

August 1, 1964

OFFICE OF INFORMATION
PROJECT DRIBBLE
U. S. ATOMIC ENERGY COMMISSION
114½ FLORENCE STREET
HATTIESBURG, MISSISSIPPI
TELEPHONE: 584-8471

OFFICE OF INFORMATION
NEVADA OPERATIONS OFFICE
U. S. ATOMIC ENERGY COMMISSION
P. O. BOX 1676
LAS VEGAS, NEVADA
TELEPHONE: 734-3011; ext. 3851

EARTH SHOCK EFFECTS

The policy of the Atomic Energy Commission regarding safety of the public is that vigorous measures will be taken to assure, as far as possible, that no one is injured because of AEC programs. The policy also is that persons living in the vicinity of project areas will be inconvenienced as little as possible in their daily lives.

The extent of earth shock from the scheduled Salmon (five-kiloton) detonation in the Tatum Salt Dome has been the subject of intensive study by an eminent panel of geophysicists since Project Dribble was initiated. Predictions of ground motion have been refined as a result of studies of the ground shock effects from a test series of chemical high explosive detonations in the salt dome.

It is believed that there is a possibility of structural damage to residences and outbuildings located within a radius of about one and one-half miles from the explosion point, with diminishing damage possible at distances out to about four and one-half miles from the explosion point. Based on studies of earthquake damage, maximum credible damage in the close-in zone could include cracking of masonry walls, unstable chimneys sheared off at the roof line (some falling through the roof), frame structures shifted on foundations, and windows broken. In the zones further from the explosion point, the maximum credible damage would be confined to some cracks in plaster and masonry, and some broken windows.

Although precautions will be taken on the basis of the damage possibilities detailed above, the predictions are assumed to be the maximum that can be anticipated, and there is general belief in the project organization that ground shock damage will be considerably less than the predicted maximum effects. Uncertainty in predicting structural damage is attributed principally to two factors: (1) No nuclear detonation has taken place in a salt dome, and the phenomena of shock transmission through various layers of the earth to the surface are not completely understood. (2) Little information exists on the extent of damage to structures from large scale underground explosions.

In the areas close in around the salt dome where possible damage is predicted, the AEC, through its contractors, will take measures to minimize damage. Each structure has been carefully surveyed and recommendations made in detail as to strengthening work which should be done, considering the condition of the individual structure and its distance from the explosion point. The work would include such measures as shoring chimneys and brick fireplaces, bracing porch roofs, stabilizing the foundations or underpinnings of houses and other buildings, and protecting breakable household items. The recommended work will be done by the government only if the owner agrees. It is estimated that the structural support program will cost $40,000.

Survey crews have examined all structures within about four and one-half miles of the shot point, so comparison can be made of conditions before and after the explosion. Representatives of the U.S. Geological Survey have checked on the condition of all wells in the same area, and representatives of the U.S. Public Health Service have visited all residents.

Arrangements have been made to make prompt settlement for any property damage, up to $5,000, caused by the explosion. Representatives of the AEC and the General Adjustment Bureau (a commercial claims adjustment agency) will investigate all claims. Technical assistance will be provided as required by the U. S. Public Health Service, the U.S. Geological Survey, and Holmes and Narver, Inc. Settlement will be made as soon as the investigating team has verified that claimed damage resulted from the underground explosion.

EVACUATION OF RESIDENTS

Because of the possible effects of ground shock, residents living within approximately one and one-half miles of the explosion point will be asked to leave their homes for a few hours. Another group of residents living in the downwind sector (probably north of the explosion point) out to a distance of about five miles also will be asked to leave their homes.

Residents living in an area extending from the zone of about one and one-half miles out to approximately two and one-half miles from the explosion point will be asked to be outdoors at the time the nuclear device is detonated. Other residents living in an area out to about four and one-half miles will be advised to remain outdoors.

It is now anticipated that the Salmon event will be fired at 10 o'clock in the morning, and that residents living in the areas to be evacuated will need to leave the area by 7:30 a.m. Roving road patrols and helicopter patrols will be operated during the time the area is empty of its residents to make sure of evacuation.

Road blocks will be established at key points around the shot point. State and local authorities will be asked to cooperate and assist in maintaining traffic control and general law and order. It is anticipated that persons who leave their homes will be able to return as soon as the road blocks are removed, probably within two hours or so after the explosion, although this is not certain. If a residence should be so badly damaged that it cannot be immediately occupied, arrangements will be made to guard the property and for temporary housing for the residents.

Residents who leave their homes at the request of the AEC will be paid a travel allowance. Each member of the family, 13 years of age or over, will be paid $10.00, and each child, under 13 years of age, will be paid $5.00. If it is necessary for residents to remain away from their homes past six o'clock in the afternoon on the day of the explosion, an additional payment based on $4.00 for each six-hour period or fraction thereof will be made to each adult member of the family. Members of the family under 13 years of age will receive $2.00 for each six-hour period or fraction thereof spent away from home.

device will be emplaced. Big Chief earlier was awarded a $520,000 contract to drill certain instrument holes at the Dribble site.

The field organization conducting the program is headed by James E. Reeves, Manager of the Commission's Nevada Operations Office.

Dr. Philip L. Randolph of Lawrence Radiation Laboratory is Technical Director for Project Dribble.

Leonard J. Yelinek is Site Manager and supervises the Atomic Energy Commission's office at 1485 West Pine Street in Hattiesburg, Mississippi. Mr. Yelinek's Hattiesburg office was established as the point of contact for residents of Mississippi with the Commission.

WORTHWHILE INFORMATION

Surface rights for the use of the 1,500 acres overlying the Tatum Salt Dome and needed for the Project Dribble experiments were obtained under a lease from Tatum Lumber Company and the Bass Pecan Company. The lease covers a ten-year period during which renewals can be made annually at the option of the government.

Sub-surface mineral rights at Tatum Dome were obtained through condemnation proceedings or by negotiation with land owners. The Order of Possession was issued by the Federal Court at Jackson, Mississippi on December 21, 1962. It was imperative that these rights be vested with the government even though no commercial deposits of oil and gas are believed present in the dome. The three programmed nuclear detonations would result in radioactive contamination of salt immediately surrounding the detonation point. Government ownership of sub-surface rights in these areas was deemed necessary.

The Tatum Dome is a typical Gulf Coast salt dome consisting of a salt core overlain by an anhydrite and limestone caprock. The top of the limestone caprock is about 900 feet below the surface, and it is about 100 to 150 feet thick. Beneath the limestone, the anhydrite caprock top is about 1,030 feet below the surface and is 450 to 470 feet thick. Thus, the virtually flat top of the salt core is approximately 1,500 feet below ground surface. In the 900 feet above the limestone caprock are layers of gravel, sand, silty clay, clay, and sandstone.

No indication has been found of oil or mineral deposits in the Tatum Dome. Oil and gas are being produced within about five miles of the explosion point. However, 16 exploratory holes drilled by oil, gas, and sulphur prospectors in the past produced no indications of commercial deposits of these minerals. Similarly, the numerous holes drilled during the exploratory and construction program for Project Dribble encountered no commercial deposits of oil, gas, or minerals. The Tatum Dome area is used chiefly for timber and livestock production.

TECHNICAL PROGRAMS

A number of scientific measurement programs have been planned in connection with the Salmon event. Four drilled holes surrounding the ground zero area will be instrumented to record particle motion both underground and at the surface. A total of approximately 71 instruments will be used in this program, which is the responsibility of Sandia Corporation of Albuquerque, New Mexico.

The Stanford Research Institute of Palo Alto, California, will use subsurface vertical velocity gauges to measure motion directly over the shot point. Vertical accelerometers will be placed in seven deep instrument holes to provide data even if the velocity gauges are destroyed as the result of the nuclear detonation. Vertical strain gauges will be placed at depths of 1,000 and 1,900 feet to measure reflected waves from the surface.

Lawrence Radiation Laboratory will employ crystal pressure gauges to measure pressures developed in the salt medium. These are expected to range from 10 kilobars, or the equivalent of 10,000 atmospheres, down to one kilobar.

Close-in ground motion will be measured by the U. S. Coast and Geodetic Survey. The measurements will be made in easterly and southerly directions from the ground-zero point. Six instruments will be placed along each line -- at distances of three-quarters, one, one and one-half, two, three, and four miles.

The U. S. Coast and Geodetic Survey also will install instruments to record the force of ground motion at the Baxterville oil field about five miles southwest of the explosion point and at the Pontiac Eastern Refinery approximately three miles north of Purvis.

Other instruments will be installed at Purvis, Wiggins, Tylertown, Prentiss, Ellisville, and Beaumont, Mississippi, and at Bogalusa, Louisiana.

Additional ground motion measurements will be made out to a distance of about 75 miles from the ground-zero location. Three stations will be operated by the U. S. Geological Survey, and four or five stations will be the responsibility of the U. S. Coast and Geodetic Survey.

Five seismic stations established as part of the nuclear test detection program (Vela Uniform) by the Advanced Research Projects Agency of the Department of Defense will measure seismic motion resulting from the detonation of the Salmon device. These stations are located at Baker, Oregon; Vernal, Utah; Payson, Arizona; Fort Sill, Oklahoma; and McMinnville, Tennessee.

Up to 40 stations located at distances greater than 1,200 miles from the Tatum Salt Dome will measure long-distance seismic motion. These stations are operated by the Geotech Corporation under the technical supervision of the Air Force Technical Applications Center. Additionally, groups of seismic prospecting teams from private geophysical organizations will record motion from the Salmon event.

Additional technical programs, not associated with the recording of seismic motion, will be implemented in connection with the Salmon event. These include studies of electric and magnetic effects, visual and photographic inspection of the Dribble site, seismic noise monitoring, and studies of solid state changes in rocks. The U. S. Coast and Geodetic Survey will attempt to record the Salmon event in the waters of the Gulf of Mexico utilizing submarine seismographs. A USC&GS ship will operate off the coast of the Yucatan Peninsula for this purpose.

Another technical program will be fielded in support of the Plowshare Program to develop peaceful uses for nuclear explosives. Nine small buildings have been erected to study the effect of ground motion on structures located at various distances from ground zero -- where extensive damage, little damage, and no damage can be expected. The buildings are of two types of construction, wood frame and concrete block. Each building has a floor, roof, one window, and one door.

Aside from the purposes of the seismic program, the Project Dribble underground nuclear detonations are expected to yield valuable information to geophysicists who are seeking to learn the makeup of the earth, from the outer mantle to the core. Recording of seismic signals from underground nuclear detonations provides information on deep underlying structures that is not obtainable by other means.

CONSTRUCTION AND COSTS

In addition to the drilling and excavating of shot holes, instrument holes, and hydrologic wells, construction at Tatum Dome included necessary site buildings, such as an office and technical building of temporary construction about two miles from the center of the site, and numbers of seismic recording stations at varying distances from the site center.

The costs of preparing for and conducting Project Dribble, including estimated costs for Sand and Tar if approval is received to prepare for them, are estimated to be about 28 million dollars. Cost of the project through June 1964 was approximately $13\frac{1}{2}$ million dollars. This includes site exploration, site preparation, drilling and excavating, and shot time and post-shot time research and scientific activities. Much of this expenditure -- particularly for payrolls and local procurement -- has been in the State of Mississippi.

VISITS TO SITE AND OBSERVATION OF SALMON EVENT

Details will be announced, in advance of the Salmon event, of arrangements for accredited news media representatives, or other authorized persons, to be admitted to the Project Dribble site for briefings and observation tours prior to the detonation.

An official observation area for news media and official observers is planned at a point about three and one-quarter miles from the site, with a line-of-sight to the tops of the trees above the surface area where the Salmon device will be detonated. All of the Dribble experiments are designed to be contained underground, and it is anticipated that there will be no publicly observable effects such as blast, heat or flash. No uncontrolled release of radioactive material to the atmosphere is expected. Observers probably will notice some earth motion.

An observation area will also be set aside for local residents. The location of this area will be announced in advance.

PUBLIC SAFETY CONSIDERATIONS

No nuclear detonation is ever authorized unless there is assurance of safety for the public. All agencies of the Government connected with Project Dribble are governed by this policy. The utmost attention is being paid to all factors that may have any influence on safety of individuals or the general public, such as ground shock, contamination of underground water, and contamination of the air.

A panel of consultants, a number of whom were recommended by the National Academy of Sciences, has reviewed the geology, hydrology, and seismology of the Dribble site. This panel works with the Dribble organization in an advisory capacity and conducts a continuing study of project proposals in terms of public safety. The panel is apprised of all matters related to geology, hydrology, and seismology which would bear on public safety.

Members of the advisory safety panel, and areas in which they specialize, are:

Dr. Perry Byerly, seismology, University of California.

Dr. Lydik S. Jacobsen, structural response to earthquakes and ground motion, California Institute of Technology.

Dr. Nathan M. Newmark, structural response and damage to mines, University of Illinois.

Dr. George B. Maxey, hydrogeology, University of Nevada.

Mr. Sheppard T. Powell, hydrology, Sheppard T. Powell and Associates.

Dr. Lewis G. von Lossberg, hydrogeology, Sheppard T. Powell and Associates.

Mr. Thomas F. Thompson, consultant in geological engineering.

The Lawrence Radiation Laboratory at Livermore, California which is responsible for the technical direction of Project Dribble, has participated in the panel's activities and contributed to the development of the safety program.

Since Project Dribble was conceived, and since the panel was organized, much new knowledge has become available about underground nuclear detonations and their effects. The Project Gnome detonation near Carlsbad, New Mexico in December, 1961 was the first nuclear detonation in salt, and it provided information valuable for determining possible effects in the Tatum Dome. Additionally, underground detonations at the Nevada Test Site since 1961 have provided data from which scientists have a better basis for determining possible effects of such detonations than was available in the past.

Analyses of past underground nuclear detonations, the known characteristics of salt and salt domes, and the known geology of the area have led to the conclusion that Project Dribble can be conducted in such a manner that uncontrolled release of radioactive products will not occur, and that air blast and thermal radiation will be contained within the deep-seated salt mass.

Even though it is believed that Project Dribble will not constitute a hazard to people, plans and organizations have been developed to deal with every eventuality, even those remote or not expected. More than $1,400,000 have been provided in the Project Dribble budget for the safety program. This includes approximately $233,000 for a drilling program to study underground water supplies, and for the establishment of seismographic safety stations.

In addition to the AEC and Department of Defense and the safety panel, ten agencies and organizations are associated with the Dribble safety program. These include the United States Coast and Geodetic Survey, the United States Weather Bureau, the United States Public Health Service, the United States Geological Survey, the United States Bureau of Mines, Hazleton-Nuclear Science Corporation, Roland F. Beers, Inc., Holmes and Narver, Inc., John A. Blume and Associates, and Reynolds Electrical and Engineering Company, Inc.

EFFECTS IN AIR

The Dribble experiment will be conducted in such a manner that an uncontrolled release of radioactive products resulting from venting to the surface is not expected. The containment expected within the deep-seated salt mass will eliminate air blast and thermal radiation. Even though the experiment is designed for full containment, with all radioactivity trapped underground, plans for rapid evacuation of a downwind sector (probably in a northward direction) have been developed so that the health of no individual would be endangered by exposure to radiation should an unplanned and highly unexpected venting situation occur. A meteorological prediction group will chart existing and predicted winds and forecast radiation hazards which could exist in case of venting.

Even though venting is considered to be only a remote possibility, any radioactivity which might vent to the surface would be carried downwind into an area (probably north of the explosion point) which could be evacuated readily prior to shot time. Field studies and safety reviews will be continued until the final planned detonation of the series, to improve estimates of the hazard and to provide information for acceptable firing conditions for the Tar and Sand events, if they are authorized.

The Salmon detonation is expected to create a large underground cavity which will be filled with gas under slight pressure. (The Gnome detonation of approximately three kilotons in a salt stratum near Carlsbad, New Mexico, resulted in a dome shaped chamber of nearly 1,000,000 cubic feet, 134 to 196 feet in diameter.)

Tentative plans have been made to drill into the expected cavity after the detonation to release or bleed off the gas. A facility has been designed (consisting of pipes and filters) to remove most of the radioactive material from the gas as it is released under controlled conditions, and to dilute the remainder to a point conforming with strict safety criteria. Release of the gas would be closely and constantly monitored. Should significant atmospheric radiation readings be anticipated or in the event of adverse weather conditions, the release of gas would be discontinued. Operational procedures would be such that amounts of radiation released would be well within the criteria established by the Federal Radiation Council.

One of the scientific purposes of Project Dribble is to determine if the cavity that is expected to be created by the detonation of the Salmon device could be re-used as a decoupled emplacement for another, larger nuclear device. In order to make such a determination, it will be necessary to lower remote-controlled camera equipment into the cavity after the high pressure gases have condensed. Knowledge gained by studying other nuclear detonations and in laboratory experiments indicates that the Salmon cavity may be filled with non-condensable gases under pressure. If so, it will not be possible to re-enter the cavity unless the pressure is bled off in advance.

EFFECTS ON GROUND WATER

The advisory panel of scientists and the engineers, technicians and scientists associated with Project Dribble are convinced that the possibility of ground water contamination in the vicinity of the salt dome is remote. All radioactivity is expected to be contained in the salt dome structure.

The earth shock is not expected to have a substantial effect on the flow or supply of ground water.

Test wells have been drilled at the Tatum Dome, and the U. S. Geological Survey has made an exhaustive study of ground water levels and amounts. The drilling program included eight exploratory and six hydrologic and observation holes which ranged from 1,000 to 4,500 feet in depth.

There are five important fresh-water aquifers in the strata above and around the dome from the surface to a depth of about 2,000 feet. Other lower aquifers contain saline water in the vicinity of the dome.

Studies indicate that the movement of ground water is slow and that adsorption characteristics of the sandy aquifers and intervening clay beds probably are high for most radioactive nuclides. The combination of high adsorption qualities and slow movement reduces the possibility of radioactivity being carried by ground water should the system be contaminated by radiation.

Nevertheless, ground water studies will be continued, and arrangements are being made to supply household and livestock water from other sources in the unlikely event that such a measure should be required.

FOREWORD

The U. S. Atomic Energy Commission and the Department of Defense are making final preparations to carry out important scientific studies at the Tatum Salt Dome in Lamar County, Mississippi. The studies, sponsored by the Department of Defense's Advanced Research Projects Agency and identified as Project Dribble, involve the recording and identification of seismic signals from a planned series of three underground nuclear detonations. These studies are important to the nation's seismic research program called Vela Uniform which is designed to improve this country's capability to detect, identify, and locate underground nuclear detonations.

The background information presented is intended to provide pertinent facts about Project Dribble. Additionally, the objectives of Project Dribble are outlined, and the preparations for the nuclear detonations (only one of which has been authorized) are described. A second section deals with precautions to be taken to assure the safety of those persons living in the vicinity of the Tatum Salt Dome.

WHAT?

Project Dribble is part of the Department of Defense program called Vela Uniform which is designed to improve this country's capability to detect, identify, and locate underground nuclear detonations. Three underground nuclear detonations have been proposed (but only one has been authorized) as part of Project Dribble. They will be set off by the Atomic Energy Commission.

The first nuclear experiment, Salmon, will involve the detonation of a five-kiloton device in a tamped emplacement at the bottom of a 2,700-foot hole. A tamped emplacement is one in which the explosive charge is fired in as small a shot chamber as possible.

The second nuclear experiment, Sand, would involve the detonation of a 100-ton device in a decoupled emplacement. A decoupled emplacement is one where the nuclear device is set apart from the surrounding earth. In this case, it is planned that the device will be emplaced in the center of a 95-foot cavity mined in the salt 2,000 feet below the surface.

The third nuclear experiment, Tar, would also involve the detonation of a 100-ton device. This device would be in a tamped emplacement 2,000 feet below the earth's surface.

WHERE?

Technical requirements of the experiments planned for Project Dribble are such that they could best be met by preparing a detonation site in a large body of salt with certain characteristics -- a minimum depth of the salt body under the earth's surface, purity of the salt, and location in an area that would permit placing seismic instruments at considerable distances from the site in several directions. Since the specifications would best be met in a salt dome, geologists gathered all known data about domes in the Gulf states where most U. S. domes are located. The Tatum Dome in Lamar County, Mississippi, seemed to meet the specifications best.

The site is located approximately 110 miles northeast of New Orleans, Louisiana, and 28 miles southwest of Hattiesburg, Mississippi. The nearest communities are Purvis, nine miles due east, and Baxterville, four and one-quarter miles southwest.

The top of the salt dome lies about 1,500 feet below the surface and is virtually level. It is about 5,000 feet in diameter. It is not known how far the dome formation extends underground, but the fact that a hole drilled at a considerable distance away from the top of the dome penetrated into salt at a depth of 6,000 feet indicates that the dome spreads out at that depth. The geological explanation of the salt domes which are common in the Gulf area is that there is a massive layer of salt many thousands of feet below the surface. Through thousands of years, pressure from the heavier strata above has resulted in columns or domes of salt thrusting upward through other formations at weak points.

The base of the Tatum Salt Dome is believed to be about 25,000 feet from the surface and it has been estimated, unofficially, that the dome may contain more than two trillion cubic feet, or 142 billion tons of salt.

WHEN?

The first of three underground nuclear detonations programmed for Project Dribble is scheduled to be ready for firing September 22, 1964. This experiment, called Salmon, will involve the detonation of a five-kiloton nuclear device at the bottom of a $17\frac{1}{2}$-inch hole drilled to a depth of 2,700 feet.

Two later nuclear detonations planned for Project Dribble involve detonation of 100-ton devices 2,000 feet under the surface. Authority for construction of the facilities required for the two experiments has not been granted. It is estimated that the two nuclear devices could be detonated, if authorized, about 22 months after construction approval is received.

Preliminary checks of seismic effects were made in April, 1963 with approximately 20 chemical high explosive shots of 500 to 4,000 pounds each. The high explosive charges were detonated in holes at least 300 feet deep. The program was conducted by the U. S. Geological Survey supported by the U. S. Coast and Geodetic Survey. The program included detonations at the Tatum Dome site and at locations 30 and 60 miles both to the north and south of the Project Dribble site.

Two 1,000-pound chemical high explosive shots were fired in holes drilled 2,000 feet deep into the salt dome during the summer of 1963 as a final check of seismic effects.

Schedules remain flexible because of technical and weather considerations and because Presidential authorization is required before any nuclear device is detonated. Only the Salmon event of Project Dribble has been authorized.

WHY?

The Vela Uniform program, of which Project Dribble is a part, evolved from recommendations made in 1959 by the Panel on Seismic Improvement (Berkner Panel), an officially appointed group of noted U. S. scientists. The Panel, taking note of difficulties in detecting the difference between some underground nuclear detonations and some earthquakes, called for a program of increased basic research in seismology; procurement of instruments for a world-wide seismic research program; development of improved seismic instruments; construction and operation of prototype seismic detection stations; and an experimental program of underground detonations encompassing both high explosives and, where necessary, nuclear explosions.

The Panel recommended firing a number of underground nuclear detonations in different locations and under varying conditions as a source of ground motion that could be recorded by improved detection instruments. Suggested placements were in granite, in an earthquake-prone area, in a cavity, and in varying geological formations at the Nevada Test Site.

The Sand Springs mountain range near Fallon, Nevada was selected as a location meeting the requirements for a granite medium and an active earthquake area. A Vela Uniform event called Project Shoal was conducted there with a contained nuclear detonation on October 26, 1963.

The detonation of a nuclear device suspended within a large cavity was recommended as a means of testing a theory that decoupling or muffling would reduce greatly the volume of seismic or ground motion signals from an underground explosion. Scientists agreed that a salt dome was the most advantageous site for such an experiment.

The decoupling theory is: If a large enough cavity were created underground, and a nuclear device of the right yield were detonated at the center of it, the air would cushion the shock and relatively little of the energy of the detonation would be transmitted to the cavity wall. Therefore, the earth shock or seismic signal transmitted to distant seismographs would be extremely small when compared to the energy transmitted from a tamped explosion of the same yield and at the same position.

Preliminary experiments, using chemical high explosive detonations in small cavities in salt, were conducted by the AEC during late 1959 and early 1960 in a salt mine near Winnfield, Louisiana. The experiments supported the decoupling theory, and supported the prediction that the seismic signals from a fully-tamped nuclear explosion would be about 200 to 300 times larger than the signal from a decoupled explosion of the same energy yield.

Firing 100-ton nuclear devices in both tamped and decoupled emplacements at the same depth (2,000 feet) in the same medium (salt) and in the same area (Tatum Salt Dome) will permit correlating and evaluating results of seismic instrument readings so that more complete knowledge of decoupling possibilities and the seismic recording of decoupled explosions can be obtained.

The purpose of the U. S. seismic research program is to design instruments that may pick up such signals, to learn how far such a signal may be transmitted, and how well the origin can be identified.

Principal purpose of the five-kiloton Salmon detonation is to provide a basis for calculating, with reasonable accuracy, the seismic signal that would be generated by a five-kiloton decoupled detonation in the Tatum Dome. When the Dribble program is completed, signals from the 100-ton decoupled explosion, the 100-ton tamped explosion, and the five-kiloton tamped explosion can be correlated, and a reasonable set of values deduced for the signal that would be created from a five-kiloton decoupled detonation in the salt dome.

Earlier plans had called for firing a five-kiloton explosion in a 340-foot diameter cavity in the salt dome. But scientists decided against the massive excavation program required to create such a cavity. Instead, they will extrapolate results of such an experiment from the remaining three detonations.

Other objectives of the Salmon event are concerned with measuring seismic waves, comparing them with signals generated from similar detonations in other media, and determining the accuracy with which the location could be determined by seismic measurements. Scientists also are interested in determining the condition of the cavity which will be created by the explosion, and assessing the feasibility of reusing the cavity for further experiments.

So far in the United States, all underground nuclear detonations have been in tamped positions in tunnels and drilled holes, and all but two -- Project Gnome in December, 1961 and Project Shoal in October, 1963 -- have been within the AEC's Nevada Test Site northwest of Las Vegas. In Project Gnome, a device of about three kilotons was detonated approximately 1,200 feet below the surface in bedded rock salt near Carlsbad, New Mexico. The project was part of the Plowshare Program for developing peaceful applications for nuclear explosives.

The Project Shoal event consisted of the detonation of a 12-kiloton nuclear device emplaced about 1,200 feet below the surface in granite. The site was located near Fallon, Nevada, and the experiment was conducted as part of the Vela Uniform Program.

More than 100 nuclear devices have been detonated in shallow or deep underground positions at the Nevada Test Site in experiments dating back to 1957. All of these detonations and the seismic signals resulting from them have been studied as part of the continuing Vela Uniform research program. The information obtained has provided United States negotiators with technical data for talks bearing on test ban matters when discussed in Geneva, Switzerland; Washington, D. C.; New York City; and other locations since 1958. These talks have been conducted in an effort to reach international agreement to ban all nuclear weapons tests.

WHO?

Prime responsibility for the Vela Uniform Program has been assigned to the Advanced Research Projects Agency (ARPA) of the Department of Defense (DOD). Project Dribble is a joint Atomic Energy Commission (AEC) - Department of Defense project.

The Lawrence Radiation Laboratory (LRL) at Livermore, California, operated for the AEC by the University of California, has been assigned the responsibility for technical direction of Project Dribble. LRL responsibility includes development of the technical program, execution of the on-site technical programs, and the analysis and reporting of experimental data.

The AEC's Nevada Operations Office (NVOO) has been assigned responsibility for managing the nuclear experiment including construction, support, detonation of the nuclear devices, and public safety.

The Army Corps of Engineers, the U. S. Geological Survey, the U. S. Coast and Geodetic Survey, the U. S. Public Health Service, and AEC contractors including Holmes and Narver, Inc., of Los Angeles, and Reynolds Electrical and Engineering Company, Inc., of Las Vegas participated in various aspects of site selection, real estate negotiations, site exploration, drilling and engineering.

Fenix and Scisson of Tulsa, Oklahoma, and Petroleum Consultants of Houston, Texas, are responsible for engineering on drilling and excavation activities at the Project Dribble site.

Edgerton, Germeshausen and Grier, Inc., of Las Vegas, a contractor to the AEC's Nevada Operations Office, is responsible for timing and firing for the Salmon detonation and for certain instrumentation work.

The U. S. Weather Bureau has organized a weather prediction unit to provide weather data and forecasts.

An off-site radiological safety organization is staffed jointly by personnel from the permanent Southwestern Radiological Health Laboratory of the U. S. Public Health Service at Las Vegas and the Southeastern Radiological Health Laboratory at Montgomery, Alabama. This organization is being supplemented by PHS reserve officers.

Early in 1964, a group of drilling and mining consultants was appointed to advise the Nevada Operations Office on the technical aspects of engineering and construction work at the Tatum Dome site.

This group includes Robert L. Loofbourow, Consulting Mining Engineer, Minneapolis, Minnesota; Dr. D. D. Utterback, Consulting Geologist, New Orleans, Louisiana; Erland Johnson, Consultant, New Iberia, Louisiana; and Lubie Martin, Consultant, Houston, Texas.

Big Chief Drilling Company of Oklahoma City, Oklahoma was awarded a $400,000 contract to drill a 2,700-foot deep hole in which the Salmon